§29. Measurements of Electron Density Fluctuation in CHS Plasmas by Using Laser Imaging Method

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We have applied a noble technique of a YAG laser imaging method for obtaining information on electron density fluctuations, including the spatial distribution in CHS plasmas. Based on last year's design, the optical system was setup and the performance was evaluated in this fiscal year.

Figure 1 shows the optical system for CHS. 5 m YAG laser (λ_i= 1.064 μm 1W) beam is transported by an SM optical fiber near CHS plasma. A radiation beam from the SM fiber is expanded and collimated by a beam-expander and passes through the plasma. After the plasma, the probe beam is transmitted through focusing and imaging lenses and a phase mirror, and received by a 16 or 32-channel fiber array connected to low noise detectors. The output power from the SM fiber was about 50 mW due to decrease of input efficiency to it. The beam width at the observing plane, which was smaller than the designed value, was 31 mm. In Table 1, performances of the system evaluated from the beam width, the laser power at the observing plane, and simulation experiments by utilizing an ultrasonic wave in the air, are shown. The measurable frequency range which is decided by the frequency response of the detector was 2 kHz to 1 MHz. Measurable wavelength range which is decided by the beam width and number of detector channels was 2 mm to 47 mm. Further, spatial resolution of about 20mm at $k=1mm^{-1}$ around the plasma edge was estimated. The minimum detectable intensity of the density fluctuation decreased to $\Delta n_e L=6.8\times10^{16} m^{-2}$ because of the decrease in the power of the probe beam and the increase of optical noise caused by a back reflection from the optical fiber.

To check the normal operation of the system, we actually applied the laser imaging system to CHS plasmas, though the minimum detectable intensity was not enough. There were two problems, which were the vibration of the optical frame and an increase of the optical noise while the electric current to the magnetic coil was on. These problems were improved by fixing the optical frame and extending the length of the optical fiber to 30 m for the YAG laser. This avoided the effect of the magnetic field and adapted an optical isolator as a countermeasure for the back reflection.

By the above improvements of the system, we will measure the density fluctuations in relation to characteristics of the confinement in the next fiscal year.

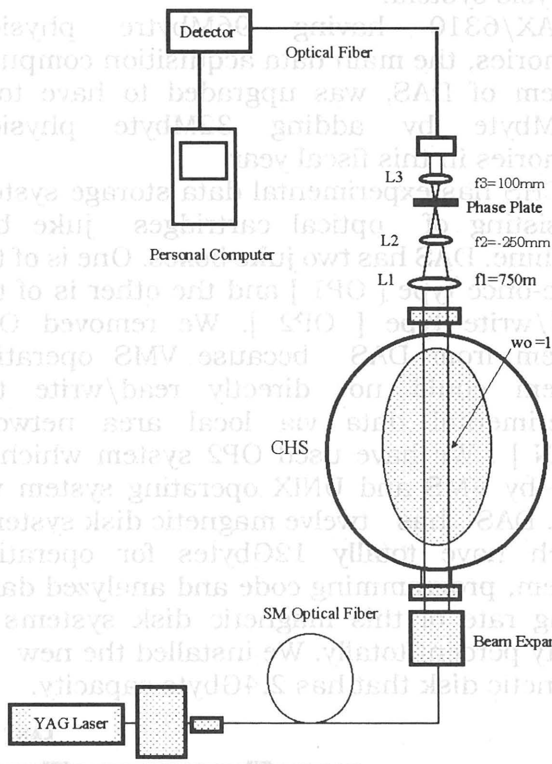

Fig.1 Laser Imaging System for CHS

Parameters of Fluctuation	Measurable Region
Frequency	2 kHz～1 MHz
Wavelength	2 mm～47 mm
Spatial resolution (at $k=1mm^{-1}$)	20 mm(r=200 mm) 60 mm(r=0)
Fluctuation intensity	$\Delta n_e L>6.8\times10^{16} m^{-2}$

Table 1 Performance of Laser Imaging System for CHS